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ABSTRACT

In an experiment designed to explore the interaction of individual differences with question pacing in learning from written materials, 93 college students were administered aptitude tests representing verbal and memory abilities and then randomly assigned to treatments in which questions were placed after every one or four pages or were omitted from a prose passage. Post-test analysis of relevant and incidental retention showed that relevant retention increased with question insertion; however, no between-group differences were found in incidental retention. Multiple regression analysis of Aptitude X Treatment interactions showed that aptitude measures interacted significantly with treatment conditions for incidental retention. Tables and references are included. (Author/AW)

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DIFFERENTIAL RESPONSE TO QUESTION PACING IN LEARNING FROM PROSE

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ABSTRACT

In an experiment designed to explore the interaction of individual differences with question pacing in learning from written materials, 93 Ss were administered aptitude tests representing verbal and memory abilities, then randomly assigned to treatments in which questions were placed after every one or four pages, or omitted from a prose passage. Posttest analysis of relevant and incidental retention showed that relevant retention increased with question insertion, however no between-group differences were found in incidental retention. Multiple regression analysis of Aptitude x Treatment interactions showed that aptitude measures interacted significantly with treatment conditions for incidental retention.

DIFFERENTIAL RESPONSE TO QUESTION PACING IN LEARNING FROM PROSE[1]

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Several experimental investigations have shown that the insertion of questions in written instructional material increases the amount learned from the text when they occur after the prose paragraphs to which they relate (Rothkopf, 1966; Rothkopf and Bisbicos, 1967; Frase, 1970). Such questions appear to have both specific and general facilitative effects upon learning, improving the retention of information both directly relevant and incidental to the questions asked. The effects of the questions have been attributed to the control which they exert over a general class of responses called "mathemagenic activities", that is, the information processing activities of the learner.

The learning that results from the insertion of questions into prose appears to be a function of several interacting components such as the position, pacing and type of questions, incentive conditions and characteristics of the textual material itself (Frase, 1970). These task variables however, have not yet been linked to learner characteristics. It is conceivable that the effects of such task variables on learning from prose may vary for different subgroups of learners, hence requiring a study of Aptitude x Treatment interactions.

There is both theoretical and empirical support for the position that learning effectiveness is a function of the interaction of instructional treatments and learner characteristics (Cronbach and Snow, 1969; Koran, Snow and

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McDonald, 1971; Koran, M.L., 1971). Accordingly, the incorporation of learner characteristics into learning research and theory is important for determining the individual parameters within which more general principles of learning might be expected to be applicable. Thus the purpose of this experiment was to investigate the interaction of learner characteristics, a dimension which has not been explicitly included in previous mathemagenic studies, with question pacing in learning from prose.

An important characteristic of questions inserted into prose is their contiguity relative to related content (Frase, 1970). It has generally been found that the effect of question pacing has been different for retention of relevant as opposed to incidental retention. The introduction of frequent questions has tended to improve retention of relevant material while depressing retention of the incidental material. However, a survey of literature provides a number of indications that different ability-performance relationships may be produced through varying the burden of semantic processing during instruction (Cronbach and Snow, 1969). Since the contiguity of questions to related content may be expected to exert control over the semantic processing which the learner gives to the textual material through selectively reinforcing the retention of question-related types of material (Frase, 1967, 1968), it was anticipated that optimal pacing of questions would vary according to learner ability to process and store verbal information. Accordingly, verbal and short term memory abilities were expected to interact with question pacing.

METHOD

Subjects

The experimental sample consisted of 93 upper-division students at the University of Texas who were enrolled in an introductory educational psychology course in the teacher education program. Participation in the experimental sessions was a course requirement.

Materials

Experimental materials consisted of a 5,000 word continuous prose passage of marine biology material comprised of a series of relatively independent factual segments dealing with minerals found in the ocean. The experimental passage was divided into 20 pages of approximately 250 words each. From each page, two questions were prepared in a constructed response format requiring the recall of specific factual information concerning names, measures and technical terms. These two questions did not overlap in terms of their content. One of each pair of questions was inserted into the text. These 20 questions served as a posttest measure of information retention relevant to questions asked in the text. The other set of 20 questions was used as a posttest measure of information retention incidental to questions asked in the text. Pretesting indicated that the two sets of questions were at the same initial level of difficulty. The specific pacing of the questions in the text was determined by the experimental condition to which each S was assigned.

Procedure

Ability measures selected from the Kit of Reference Tests for Cognitive Factors (French, Ekstrom and Price, 1963) were Vocabulary (Verbal Comprehension) and First and Last Names (Associative Memory) tests. Following administration of

the aptitude tests, Ss received one of three treatment conditions in which questions were inserted after every one or four pages of text, or completely omitted from the prose passage. The same set of questions was always used, but the questions occurred in groups of 0, 1 or 4 depending on the specific treatment condition.

The three forms of the prose material were arranged in random order and distributed to the subjects. After receiving the passage, Ss were instructed to read the material carefully, turning each page face down after reading it. The instructions stressed that Ss were not to review any page after having read it. They were told to answer the questions as they encountered them in the text and that they would be tested on the material when finished. Ss were not permitted to examine the passage while considering the questions.

When the reading task was completed, Ss went directly on to the criterion test placed at the end of the prose material. The 40-item criterion test was given as a unit, but consisted of both relevant and incidental questions. The order of the items was randomly determined. No time limit was imposed upon the completion of either the reading materials or the criterion test.

RESULTS

Treatment Effects

Relevant and incidental retention scores on the criterion test were analyzed separately. One-way analysis of variance was used to test instructional treatment main effects. The Newman-Keuls procedure was used in comparisons of pairs of treatments following an overall significant F ratio, (Winer, 1962). Means and standard deviations of the independent and dependent variables are reported for each treatment group in Table 1. Table 2 presents the analysis of variance results.

Highly significant treatment effects were found for retention of relevant information ($F = 15.14$, df 2/90, $p < .001$). Comparisons between pairs of treatments showed that both treatment groups receiving questions during the prose passage produced significantly higher relevant retention scores than did the control treatment ($p < .01$), although the two experimental groups did not differ significantly from each other. Retention of relevant information was relatively high for both experimental groups regardless of the pacing of the questions. Significant between-group differences were not obtained for retention of incidental information, although Ss in the treatments receiving the infrequent questions performed somewhat better than control Ss. These treatment effects are in accord with those obtained in previous research in which the insertion of questions has clearly had a more powerful effect upon the retention of relevant information than upon retention of incidental information (Frase, 1968). The effects of variations in question pacing, while somewhat weaker than those previously obtained, also indicate that optimal question pacing may differ for retention of relevant as opposed to incidental content (Frase, 1967).

Aptitude X Treatment Interactions

Both single and multiple regression analysis was used to evaluate Aptitude X Treatment interactions, using F tests for heterogeneity of regression. Multiple regression analysis was used in comparing regression planes obtained for the combination of aptitude variables and each criterion score for different treatments. This was done as a first step in determining whether there were significant Aptitude x Treatment interactions. If an overall interaction was obtained, more specific hypotheses were tested by comparing regression slopes, for each aptitude-criterion pair separately (Cronbach and Snow, 1969). These results

are summarized in Table 3.

Multiple regression analysis of Aptitude x Treatment interactions disclosed that regression planes obtained for the combination of aptitude variables interacted significantly with treatment conditions for the retention of incidental information ($F = 2.49$, df 4/83, $p < .05$). Further comparison of specific aptitude-criterion pairs showed that scores on the First and Last Names test produced a significant interaction ($F = 3.28$, df 2/83, $p < .05$) in which the memory scores were positively related to performance in both treatment groups receiving questions, while unrelated to performance in the control treatment. Comparisons using the Vocabulary test scores, while approaching significance ($F = 2.27$, df 2/83, $p < .11$), did not produce a significant interaction. Scores on the Vocabulary test were positively related to performance in the control treatment and the infrequently questioned group. while unrelated to performance in the frequently questioned group.

Multiple regression analysis did not disclose a significant interaction of regression planes for retention of relevant information ($F = 1.48$, df 4/83, $p < .21$), therefore more specific comparisons were not tested. However, the pattern of relationships obtained for relevant retention corresponded closely to that obtained for incidental retention.

DISCUSSION

It will be recalled that the major purpose of this experiment was to examine the effects of learner characteristics with question pacing in learning from prose. It was anticipated that optimal pacing of questions would vary according to learner ability to effectively process and store verbal information. Therefore verbal and short term memory abilities were expected to interact with question

pacing. Aptitude x Treatment inceraction was obtained for retention of incidental information, although not for relevant retention. It is interesting to note in this regard that in previous study of verbal learning (Plenderleith and Postman, 1956, 1957), individual difference variables were found to be of greater importance in incidental learning than in intentional learning, presumably because the higher motivation of intentional learning obscures differences in habits and sets.

Taken as a whole, the pattern of ability-performance relationships in the Aptitude x Treatment interaction obtained for retention of incidental information suggests that frequent selective reinforcement of Ss' attention to specific aspects of the prose passage, such as names, measures or technical terms, may reduce the burden of semantic processing and capitalize on the role of associative memory.

As Rothkopf has pointed out (Rothkopf and Bisbicos, 1967), questions requiring names, measures or technical phrases for responses can be derived from only a limited number of sentences in the experimental passage, whereas questions requiring common words as responses can be formed from nearly every sentence. By selectively reinforcing attention to question-related types of material in the prose passage, reduction in verbal processing requirements may be expected to accrue. Since the questions serve to reinforce and maintain mathemagenic activities appropriate to the nature of the task, increased pacing of questions should insure more efficient maintenance (Frase, 1968), thus primarily benefiting less verbally able Ss. Moreover, if verbal comprehension scores are taken as an aspect of conventional mental ability, it is possible that lower-ability Ss are weak primarily in attentional and discrimination skills, as suggested by Zeaman and House (1967). Accordingly, the insertion of frequent question may compensate for this lack through their attention directing and controlling features, thus accounting for their

beneficial effect upon low ability Ss.

Interestingly, while the relationship of Verbal Comprehension scores to retention of incidental information decreased with increased question pacing, the relationship of First and Last Names scores to incidental retention increased. It is possible that the ability to form and remember new associations cannot fully be capitalized upon until the explicit nature of the associations to be formed and remembered are made clear. In the absence of such clarification Ss high in memory ability may actually do poorly either because the associations that are formed are irrelevant to the learning task or because they try to retain too much detail (Wicklegren and Cohen, 1962).

In the First and Last Names test, Ss examine 30 full names, and are told that later, when the last names are presented in a different order, they will be required to write in the appropriate first name. Hence the nature of the associations to be formed is quite clear. However, in learning from connected discourse this is typically not the case. As was previously mentioned, in the present experiment questions could conceivably be formed from nearly every sentence. When specific knowledge of the associative requirements of the task is lacking, verbal mediational processes may become of more fundamental importance in producing individual differences in learning, as suggested by the relationship of Verbal Comprehension scores to incidental retention in this experiment. However, by reinforcing Ss attention to the relevant, question-related types of material in the prose passage, the insertion of questions may serve to clarify the nature of the associations to be formed and thus allow associative memory to be more effectively utilized. Again, increased pacing of questions would be expected to enhance this effect, as appeared to be the case in this experiment. Thus,

Aptitude x Treatment interactions may again be viewed as arising from a compensatory-conciliatory process in which some harmony is achieved between learner proficiencies, learner deficiencies and the characteristics of the instructional treatment (Cronbach and Snow, 1969; Koran, Snow and McDonald, 1971; Koran, 1971).

The research described is representative of initial efforts to match instructional methods to selected learner characteristics. Replication should clearly precede attributing practical significance to these results. Additional reflection would undoubtedly suggest a variety of ways in which the aptitude measures, instructional materials and criterion measures might be varied to alter the results obtained. For example, most important educational goals do not entail the type of verbatim recall required in this experiment (Watts and Anderson, 1971). The extent to which the ability-performance relationships obtained in the present experiment may be altered when questions require students to apply concepts or principles described in a passage must be empirically determined. However, experimentation such as this may eventually provide decision rules for the assignment of students to alternative treatments.

Table 1

Means and Standard Deviations of Independent and Dependent Variables

Treatments	Vocabulary		First and Last Names		Relevant Retention		Incidental Retention	
	M	S.D.	M	S.D.	M	S.D.	M	S.D.
Frequent Questions	17.19	6.69	22.84	6.40	12.06	3.29	6.81	2.82
Infrequent Questions	18.12	5.81	20.67	7.01	11.58	3.47	7.65	2.58
No Questions	19.63	5.85	22.76	6.86	7.64	3.51	7.38	2.80

Table 2

Analysis of Variance for Posttest Scores

Source	df	Relevant Retention		Incidental Retention	
		MS	F	MS	F
Between Groups	90	182.14	15.14*	5.72	.70
Within Groups	2	12.03		8.19	

*p < .01

Table 3

Multiple Regression Analysis of Aptitude X Treatment Interaction

Treatment Group	Relevant Retention			Incidental Retention		
	a	b_1 Vocabulary	b_2 First and Last Names	a	b_1 Vocabulary	b_2 First and Last Names
Frequent Questions	3.39	.13	.15*	1.02	.09	.18**
Infrequent Questions	3.46	.20*	.22**	.60	.25**	.12*
No questions	2.16	.30**	-.01	2.88	.28**	-.04

*p < .05
**p < .01
Note: $\hat{Y} = a + b_1 x_1 + b_2 X_2$

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